

Remarks

Applicant has filed this Amendment in response to the Office Action dated December 14, 2004. Claims 23, 45-46, 60 and 63 have been amended. Claims 1-19, 27-39, 57-59 and 62 have been canceled without prejudice. Claims 20-26, 40-56, 60-61 and 63-67 are currently pending. Reexamination and reconsideration are respectfully requested.

Claim 63 was objected to for an informality. Applicant has amended claim 63 as suggested by the Examiner.

Claims 20-25 were rejected under 35 U.S.C. 103(a) as unpatentable over U.S. Patent No. 6,064,105 to Li et al. ("Li") in view of U.S. Patent No. 6,609,058 to Hong ("Hong") and U.S. Patent No. 6,548,373 to Chuang et al. ("Chuang"). The rejection is respectfully traversed.

Applicant respectfully submits that the Examiner's citations to the art do not describe or suggest a method having all of the elements of claim 24. Moreover, one of ordinary skill in the art would have no motivation to make the proposed combination including Chuang and Li as suggested by the Examiner.

The Examiner stated on page 3 of the Office Action that "[t]he combined device differs from the claimed invention by not showing thermally treating the dielectric layer after the forming the sacrificial oxide layer. However, Chuang et al. (figures 1a-c) teach thermally treating the dielectric layer (110) after forming sacrificial oxide layer (103) (column 3, lines 5-44)." Thus the Examiner appears to be equating the sacrificial layer 103 of Chuang with the layer 146 of Li, which was referred to by the Examiner as a sacrificial oxide layer on page 3 of the Office Action. However, the sacrificial layer 103 of Chuang appears to be formed at a substantially different stage of the processing than the layer 146 of Li.

The Examiner stated that Li describes "forming a sacrificial oxide layer (oxide layer [146]) in direct contact with the first layer (112) (portions of layer [146] is in direct contact with the portions of the first layer [112]; figure 3k) after the removing the pad layer (114).

Chuang, on the other hand, appears to describe forming sacrificial layer 103 prior to removing the pad layer. Chuang, at col. 3, lines 11-13, recites in part "[a] sacrificial layer 103 having a thickness of about 500A to 1000A is formed over the pad oxide layer 102." Thus, the layer 103 is formed prior to any removal of the pad layer 102. Moreover, the sacrificial layer 103 in Chuang is formed early in the process and is formed as a sandwich structure between the "pad

oxide layer 102" and the "mask layer 104 such as a silicon nitride layer". (see Chuang at col. 3, lines 5-24.) The trench formation in Chuang appears to take place after formation of the sacrificial layer 103, whereas in Li the trench formation appears to take place prior to formation of the layer 146. In addition, the layer 146 in Li does not appear to be formed in a sandwich structure such as that in Chuang. (see Li at col. 5, lines 21-31).

As set forth above, the "sacrificial layer 103" of Chuang refers to a substantially different layer formed at a different step in a different process and as a result, one of ordinary skill would not make the combination suggested by the Examiner. Moreover, a combination including Chuang would change the process steps in a manner that does not describe or suggest all of the elements recited in the claims. Accordingly, the rejection of claim 24 should be withdrawn.

Claims 20-23 and 25 depend from claim 24 and the rejection of these claims should be withdrawn for at least the same reasons as claim 24. In addition, claim 23 has been amended to recite "after the implanting impurities to form a well in the first layer, removing the entire sacrificial oxide layer". Applicant respectfully submits that the Examiner's citations to the art do not describe or suggest such a method. (See the discussion of independent claim 63 below, which includes an element in some ways similar to that in claim 23.)

Claim 26 was rejected over Li, Hong and Chuang and further in view of U.S. Patent No. 6,165,854 to Wu ("Wu"). The rejection is respectfully traversed. Claim 26 depends from claim 24, and for at least the same reasons as claim 24, applicant respectfully requests that the rejection of claim 26 be withdrawn.

Claims 40-42, 47-49 and 51-56 were rejected under 35 U.S.C. 103(a) as unpatentable over Li in view of U.S. Patent No. 6,087,243 to Wang ("Wang") and U.S. Patent No. 6,221,735 to Manley et al. ("Manley"). The rejection is respectfully traversed.

The Examiner appears on page 6 of the Office Action to have cited Wang as relating to thermally treating a trench dielectric layer after removing the polishing stopper layer. Wang, at col. 6, lines 53-60, recites the following:

Silicon nitride layer 13 is then removed leaving a pad oxide layer of about 100 Å to about 300 Å, typically about 150Å. Retrograde well implants are then formed, as by ion implantation. Heating is then conducted . . . during

which the oxide trench fill is densified and the retrograde implants activated to form retrograde wells . . .

Thus it appears that the thermal treatment the Examiner is citing takes place after forming retrograde implants by ion implantation. Moreover, the thermal treatment of Wang also serves to activate the implants.

The Examiner then on page 7 of the Office Action cited Manley for "implanting ions into the substrate after the annealing step of the dielectric layer (column 3, lines 47-50)." Manley, as cited by the Examiner, also appears to describe performing a thermal treatment prior to ion implantation.

Moreover, the Wang reference describes forming a well by ion implantation prior to performing a thermal treatment of the trench oxide, whereas Manley as cited by the Examiner describes as forming a well by ion implantation after performing a thermal treatment. The Examiner cited no portion of the art that suggests that one of ordinary skill would change the order of the process of Wang as suggested by the Examiner. Indeed, Wang specifically notes that the heating performs the functions of both densifying the oxide trench fill and activating the implants. One of ordinary skill would find no reason, in the art as cited by the Examiner, to change the order of steps as suggested by the Examiner, as the heating would not then perform both functions set forth in Wang.

Accordingly, applicant respectfully submits that for at least the reasons stated above, the Examiner has not met the proper burden to establish obviousness and as a result, the rejection of claim 40 and its dependent claims 41-42, 47-49 and 51-56 should be withdrawn.

Claim 43 was rejected over Li in view of Wang and Manley, and further in view of U.S. Patent No. 6,258,692 to Chu et al. ("Chu") and U.S. Patent No. 6,265,269 to Chen et al. ("Chen"). The rejection is respectfully traversed. Claim 43 depends (indirectly) from claim 40. The additional art to Chu and Chen does not overcome the deficiencies of the combination of Li, Wang and Manley as discussed above. Accordingly, for at least those reasons, the rejection of claim 43 should be withdrawn.

Claims 44-46 were rejected over 35 U.S.C. 103(a) as unpatentable over Li in view of Wang, Hong, Chu and Chen. The rejection is respectfully traversed.

The Examiner appears on page 12 of the Office Action to have cited Wang as relating to thermally treating a trench dielectric layer after removing the polishing stopper layer. As described above, it appears that the thermal treatment the Examiner is citing takes place after forming retrograde implants by ion implantation. In addition, the thermal treatment of Wang also serves to activate the implants.

The Examiner then on page 12 of the Office Action cited Hong for "ions implanting to form a well after the thermally treating the dielectric layer (32) (column 2, lines 6-43."

Thus, the Wang reference describes forming a well by ion implantation prior to performing a thermal treatment of the trench oxide, whereas Hong as cited by the Examiner describes as forming a well by ion implantation after performing a thermal treatment. The Examiner cited no portion of the art that suggests that one of ordinary skill would change the order of the process of Wang as suggested by the Examiner. Indeed, Wang specifically notes that the heating performs the functions of both densifying the oxide trench fill and activating the implants. One of ordinary skill would have no reason to change the order of steps as suggested by the Examiner, as the heating would not then perform both functions set forth in Wang.

Applicant further notes that the Examiner on page 13 of the Office Action stated it would be obvious to combine Chu and Chen with the other references 's citations to Chu and Chen on for performing isotropic etching "in order to create a smooth etching surface . . ." However, no citation to the art was provided for the quoted statement above, "in order to create a smooth etching surface . . ." The Examiner provided no other motivation or suggestion for the combination of these references.

For at least the reasons above, applicant respectfully submits that the rejection of claim 44 should be withdrawn.

Dependent claims 45-46 are patentable for at least the same reasons as claim 44. In addition, applicant respectfully submits that the cited art does not describe or suggest a method including all of the elements of claims 45-46, as amended.

Claim 50 was rejected under 35 U.S.C. 103(a) as unpatentable over Li and Wang in view of Manley and further in view of Wu. The rejection is respectfully traversed. The Examiner cited no portion of Wu that overcomes the deficiencies of the combination of the other art as described above for claim 40, from which claim 50 depends. Accordingly, for at least the same

reasons as described above for claim 40, applicant respectfully requests that the rejection of claim 50 be withdrawn.

Claims 60-61 were rejected under 35 U.S.C. 103(a) as unpatentable over Li in view of Hong. The rejection is respectfully traversed. Applicant has amended claim 60 for clarity.

The Examiner stated on page 15 of the Office Action that "Li et al. differ from the claimed invention by not showing heating the dielectric layer after the removing the polishing stopper layer and the pad oxide." The Examiner then cited Hong as describing "removing the portion of the polishing stopper layer (24) and the pad oxide (22) (figure 4) and heating the dielectric layer (32) column 2, lines 30-38) (figure 5)." However, applicant notes that this description of Hong by the Examiner as "removing the portion of the polishing stopper layer (24) and the pad oxide (22)" appears to relate to removing part of the polishing stopper layer 24 and pad oxide 22 prior to forming the trench. This does not describe "heating the dielectric layer . . . after the removing the polishing stopper layer and the pad oxide layer" as recited in claim 60. This is because the element of claim 60 that recites in part "removing the polishing stopper layer and the pad oxide layer" occurs "after the planarizing the dielectric layer."

Accordingly, the Examiner's citation to Li in view of Hong fails to describe or suggest all of the elements of claim 60. As a result, the rejection of claim 60 and its dependent claim 61 should be withdrawn.

Claims 63-65 and 67 were rejected under 35 U.S.C. 103(a) as unpatentable over Li in view of Chuang and Manley. The rejection is respectfully traversed. Claim 63 was amended for clarity.

Applicant respectfully submits that the Examiner's citation to the art does not describe or suggest all of the elements in claim 63, which, as amended, recites in part:

forming a sacrificial oxide layer on the exposed epitaxial layer, after the removing the pad layer;
thermally treating the dielectric layer at a temperature of at least 1050°C after the forming the sacrificial oxide layer;
after the thermally treating the dielectric layer at a temperature of at least 1050°C, implanting impurity ions in the epitaxial layer; and
after the implanting impurity ions, removing the entire sacrificial oxide layer.

The Examiner stated that on page 18 of the Office Action that the "combined device shows . . . removing the sacrificial oxide layer (a portion of layer [146] is removed as shown in figure 31; a opening 152)." Applicant notes that layer 146 is described in Li as "a high voltage gate oxide 146" (see Li at col. 5, line 22) and not as a sacrificial layer, although the Examiner is accurate in that a portion of layer 146 is removed as shown in Li Fig. 31. However, applicant respectfully submits that one of ordinary skill, upon reading Li and its description of layer 146, would not be motivated to remove "the entire sacrificial layer" as recited in claim 63. Accordingly, applicant respectfully requests that the rejection of claim 63 be withdrawn. The rejection of dependent claims 64-65 and 67 should also be withdrawn for at least the same reasons as for claim 63.

Claim 66 was rejected under 35 U.S.C. 103(a) as unpatentable over Li, Chuang, Manley and further in view of Wu. The rejection is respectfully traversed. Applicant respectfully submits that the rejection of claim 66 should be withdrawn for at least the same reasons as claim 63 as described above. The citation to Wu does not overcome the deficiencies of the other art.

The Office Action also included various comments concerning the art and the non-patentability of features in certain of the claims. Applicant notes that the Examiner's comments in the Office Action that have not been specifically discussed above are deemed moot at this time in view of this response. Applicant respectfully submits that the pending claims are in patentable form. Reexamination and reconsideration are respectfully requested. If, for any reason, the application is not in condition for allowance, the Examiner is requested to telephone the undersigned to discuss the steps necessary to place the application into condition for allowance.

Respectfully submitted,

Alan S. Raynes

Alan S. Raynes

Reg. No. 39,809

KONRAD RAYNES & VICTOR, LLP

315 South Beverly Drive, Suite 210

Beverly Hills, CA 90212

Customer No. 24033

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(310) 556-7983 (tele general)

(310) 871-8448 (tele direct)

(310) 556-7984 (facsimile)

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Alan S. Raynes

Alan S. Raynes

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(Date)